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AN INTRODUCED KNAPWEED GALL FLY, *UROPHORA QUADRIFASCIATA* (MEIGEN) (DIPTERA: TEPHRITIDAE), IN NORTH AMERICA: NORTHEASTERN AND SOUTHEASTERN RANGE EXTENSIONS

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Abstract.—The knapweed gall fly *Urophora quadrifasciata* (Meigen), native to Eurasia, was released in British Columbia, Canada, in 1970 to help control infestations of Eurasian knapweeds, *Centaurea* spp. (Asteraceae), in rangelands. After the tephritid had dispersed into Idaho and Montana by the early 1980s, it was approved for release in the United States as a biological control agent. Released in northeastern North America only in Quebec, Maryland, and New York, *U. quadrifasciata* has spread to other provinces and states. It is newly reported from New Brunswick (1 county) and Nova Scotia (3 counties) as the first records from the Canadian Maritime Provinces and from North Carolina (12 counties) as the southeasternmost records in North America. Populations in the Maritime Provinces are attributed to dispersal from established populations in Quebec or New England; in North Carolina, the fly likely dispersed from established populations in Virginia.

Key Words: Insecta, Diptera, *Urophora,* biocontrol, non-native species, dispersal, knapweed, *Centaurea*

Two Eurasian knapweeds of the genus *Centaurea* (Asteraceae = Compositae) were accidentally introduced with commerce into the Pacific Northwest during the late nineteenth and early twentieth century. Spotted knapweed, *C. biebersteinii* DC (= *C. maculosa* auct. non Lam.; *sensu* Kartesz 1999), was detected at Victoria, British Columbia, in 1893. Diffuse knapweed, *C. diffusa* Lam., was first collected in southern Washington in 1907 (Watson and Renney 1974). Both species have become important weeds in western pastures and rangelands. Because of their allelopathic properties and other biological attributes, these adventive plants tend to form solid stands and to displace native herbaceous plants (Fletcher and Renney 1963, Harris and Cranston 1979, Maddox 1982, Müller-Schärer and Schroeder 1993, Sheley et al. 1998). Allelopathy appears to have been particularly critical to spotted knapweed's success as an exotic invader (Bais et al. 2003). The economic importance of *C. biebersteinii* and *C. diffusa* in western North America includes reduced forage production, decreased carrying capacity of ranges, and detrimental effects on soil and water resources, in addition to the cost of herbicide applications (Watson and Renney 1974, Harris and Cranston 1979, Maddox 1979, Sheley et al. 1998). Both knapweeds (especially *C. biebersteinii*) are established in eastern North America, mainly along highways and railroad rights-of-way and in abandoned fields, poorly managed pastures, and other dis-

turbed sites (Mays and Kok 2003). These species, however, are of lesser economic importance in the East than they are in western rangelands (T.A. Wheeler and Varady-Szabo 2002).

A complex of Eurasian insects has been intentionally introduced to help reduce knapweed densities (e.g., Müller-Schärer and Schroeder 1993, Lang et al. 2000, Bourchier et al. 2002). These biological control agents include the seedhead gall flies *Urophora affinis* Frauenfeld and *U. quadrifasciata* (Meigen). Both tephritids were released in British Columbia in the early 1970s (Harris 1980), with *U. affinis* released in the United States in Montana and Oregon in 1973. *Urophora quadrifasciata* was not released initially in the western United States but was recovered in Idaho in 1980 and Montana in 1981, apparently as a result of dispersal from release sites in British Columbia (Story 1985, Lang et al. 1997). In the late 1980s, the U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, began a national program to redistribute *U. affinis*, *U. quadrifasciata*, and other knapweed biocontrol agents (Lang et al. 1997). As a result of intentional releases coupled with natural dispersal (and possibly the movement of infested knapweed seed heads in commerce), *U. quadrifasciata* has become established in Alberta, British Columbia, Ontario, and Quebec in Canada (Bourchier et al. 2002, T.A. Wheeler and Varady-Szabo 2002) and in 25 U.S. states (Hoebeke 1993, A.G. Wheeler and Stoops 1996, Lang et al. 1997). In the central and eastern states, *U. quadrifasciata* has been reported from New Hampshire to Virginia west to Indiana, Michigan, and Minnesota (Lang et al. 1997).

Here, we extend the known distribution of *U. quadrifasciata* to New Brunswick and Nova Scotia in the Northeast and North Carolina in the Southeast. Specimens were collected in the Canadian Maritime Provinces on *C. nigra* L., black knapweed, by E.R.H. in 1997 and E.R.H. and A.G.W. in 2001 and 2003, and in North Carolina on *C. biebersteinii* by A.G.W. Voucher material is deposited in the Cornell University Insect Collection, Ithaca, New York.

CANADA: New Brunswick: St. John Co., St. John, 21 July 1997, 2 ♀. Nova Scotia: Annapolis Co., Port George, 5 Aug. 2001, 1 ♂, 1 ♀; Colchester Co., Truro, along railroad, 29 July 2003, 2 ♀ & 3 Aug. 2003, 2 ♂; Halifax Co., Dartmouth, 27–28 July 2003, 6 ♂, 7 ♀ (including a mating pair) & 3 Aug. 2003, 4 ♂, 2 ♀; Kings Co., Wolfville, Acadia University, 4 Aug. 2001, 4 ♀; Pictou Co., New Glasgow, along railroad, 3 Aug. 2003, 4 ♂. UNITED STATES: North Carolina: Alleghany Co., Sparta, Rt. 21, 15 June 2002, 2 ♂, 2 ♀; Buncombe Co., Asheville, Clingman Ave., along railroad, 20 July 2002, 2 ♂, 2 ♀; Candler, Rts. 19/23, 6 July 2003, 1 ♂, 1 ♀; Enka, Rts. 19/23, 29 June 2002, 2 ♂; jct. rts. 19/23 & 197, 4.5 km E of Jupiter, 12 July 2003, 1 ♂, 1 ♀; Catawba Co., jct. Rt. 10 & Robinson Rd., 6 km SW of Newton, 24 July 2002, 2 ♂, 2 ♀; Cherokee Co., Rt. 64, 0.65 km E of jct. Rt. 294, 12 km SW of Murphy, 28 June 2003, 4 ♂, 2 ♀; Haywood Co., Canton, 29 June 2002, 3 ♂, 3 ♀& 6 July 2003, 1 ♂, 2 ♀; Cruso, Rt. 276, 29 June 2002, 1 ♂, 1 ♀; Henderson Co., jct. Rt. 225 & SR-1829 (Kay Rd.), 2.2 km SE of Flat Rock, 29 June 2002, 1 ♂, 2 ♀; Iredell Co., I-40 West exit 146 (Stamey Farm Rd.), 7 km W of Statesville, 24 July 2002, 1 ♂, 1 ♀; Jackson Co., Rts. 23/74, W of Haywood Co. line, 4 July 2002, 1 ♂, 1 ♀; Madison Co., Mars Hill, Rt. 213, 12 July 2003, 1 ♀; Person Co., Woodsdale, along railroad, 6 July 2002, 1 ♂, 3 ♀; Rockingham Co., jct. US Bus. Rt. 29 & SR-2557 (Mellow Rd.), 9.5 km NNE of Reidsville, 6 July 2002, 2 ♂, 2 ♀; Watauga Co., Rt. 421, 1.1 km E of jct. Rt. 194 North, 2 km E of Boone, 5 July 2003, 4 ♂, 2 ♀; Boone, Rt. 105, 15 June 2002, 2 ♂, 4 ♀.

Discussion

Lang et al. (1997) predicted that *U. quadrifasciata*, a more rapid disperser than

U. affinis (e.g., Harris 1980, Harris and Myers 1984), will continue to spread into knapweed-infested regions of North America. This tephritid recently was reported new to Ontario and from several sites in Quebec, including the Gaspé Peninsula (T.A. Wheeler and Varady-Szabo 2002). Its establishment in eastern Canada was attributed to continued dispersal from populations in the central and eastern United States rather than to the 1979 release of the gall fly in southwestern Quebec. T.A. Wheeler and Varady-Szabo (2002) collected adults in eastern Canada by sweeping mixed vegetation, but they assumed that the host in eastern Quebec (Forillon National Park) was the Old World *C. nigra* because *C. biebersteinii* (as *C. maculosa*) has not been recorded from the park.

Our collections of *U. quadrifasciata* in New Brunswick and Nova Scotia are the first for the Canadian Maritime Provinces. This tephritid apparently has not been released in the Maritimes (Harris and Myers 1984, Bourchier et al. 2002). We collected adults only on flower heads of black knapweed in New Brunswick and Nova Scotia. In Nova Scotia, *C. nigra* is "common throughout the province," whereas *C. biebersteinii* is found only locally in Kings County (Zinck 1998). Our experience with *U. quadrifasciata* in the Maritimes supports T.A. Wheeler and Varady-Szabo's (2002) suggestion that this tephritid uses black knapweed as a host in certain areas of eastern Canada. *Urophora quadrifasciata* in eastern North America has been collected from *C. jacea* L. and *C. nigrescens* Willd. (as *C. dubia* Suter) in addition to *C. biebersteinii* and *C. nigra* (Hoebeke 1993, Ruhren 2000).

We suggest that *U. quadrifasciata* has spread to New Brunswick and Nova Scotia from Quebec or the New England states and that its establishment is recent. It was detected in New Brunswick in 1997. While collecting the Palearctic pteromalid wasp *Pteromalus elevatus* (Walker), a parasitoid of the accidentally introduced gall fly *U. jaceana* (Hering), we swept flower heads of *C. nigra* in Nova Scotia during late June and late July 1993–1995 without finding *U. quadrifasciata* (Hoebeke and Wheeler 1996; E.R.H. and A.G.W., unpublished data). Our sampling included Dartmouth and Truro, where we found this tephritid on *C. nigra* in late July and early August 2003. Fewer than 10 individuals of *U. quadrifasciata* were observed at all but one of our collection sites in 2001 and 2003.

We collected *U. quadrifasciata* on spotted knapweed in North Carolina in the central piedmont and mountains. The tephritid likely dispersed to North Carolina from populations in Virginia that have been attributed to dispersal from previously established populations in more northern states (A.G. Wheeler and Stoops 1996, Mays and Kok 2003). *Urophora quadrifasciata* was not released in either Virginia (Mays and Kok 2003) or North Carolina (K.A. Kidd, personal communication). The North Carolina State University insect collection does not have North Carolina material of this species (R.L. Blinn, personal communication).

Although in North Carolina we collected the tephritid in Cherokee County within 5 km of the Georgia line and in Henderson County within 12 km of the South Carolina line, its spread to those states might not be imminent. Known hosts of *U. quadrifasciata* in Europe and North America, mostly species of *Centaurea* in the subgenera *Acrolophus* and *Jacea* (Zwölfer 1965, Sobhian and Zwölfer 1985, White and Korneyev 1989, Rees and Story 1991, Hoebeke 1993), are not known from or are rare in Georgia and South Carolina (Duncan and Kartesz 1981, Jones and Coile 1988, Kartesz 1999, Weakley 2002). Spotted knapweed, although known historically from Greenwood County, South Carolina, is not currently known from the state (P.D. McMillan, personal communication). It also is not known from Georgia (Kartesz 1999). Colonization of novel hosts in Georgia and South Carolina, however, is possible be-

cause *U. quadrifasciata* exhibits a wider host range within the subtribe Centaureinae than do most other species of the genus (Ponisch and Brandl 1992). The atypically broad host range also suggests the possibility that a sibling complex is involved (White and Korneyev 1989).

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